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THE OCCURRENCE OF GLACIAL DRIFT ON THE MAGDALEN ISLANDS

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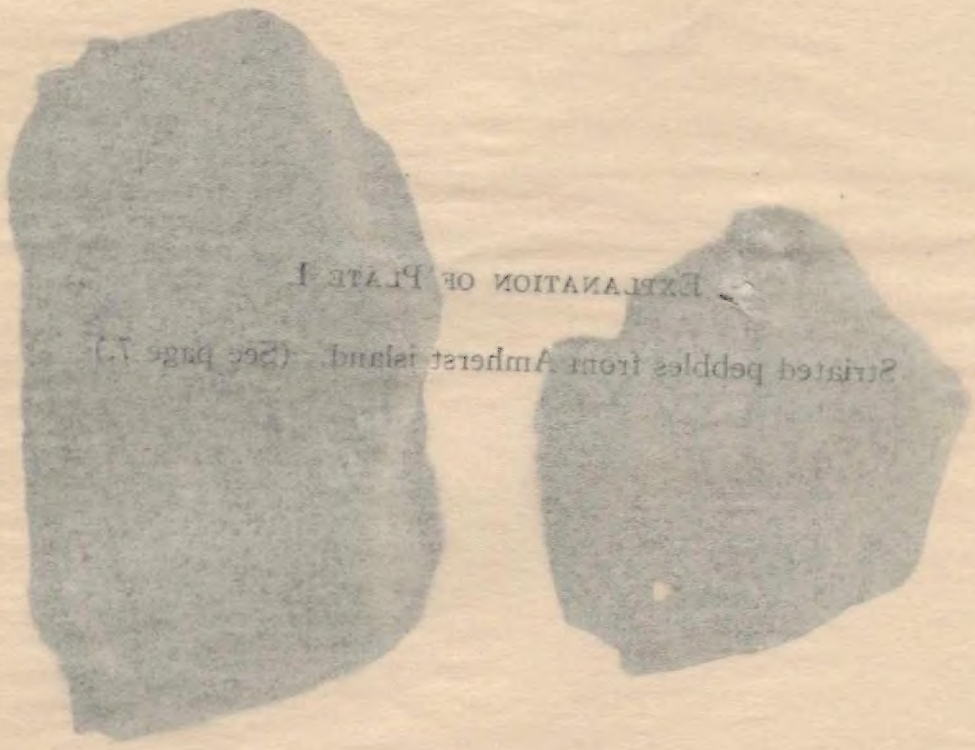
CONTENTS.

ILLUSTRATIONS.

Explanation of Plate I.

Striated pebbles from Amherst island. (See page 7.)



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INTRODUCTION.

The Magdalen islands lie nearly in the centre of the Gulf of St. Lawrence, about 50 miles northwest of Cape Breton and northeast of Prince Edward Island. They consist of thirteen small islands, spaced well apart along a northeast-southwest line and tied together by a double line of sand bars (Figure 1). The deeply drowned valley which forms the seaward continuation of the St. Lawrence estuary passes straight by the northern end of the Magdalens, in its course from Gaspe to Cabot strait. The islands thus lie near the northern edge of the vast submerged plain which occupies the southern embayment of the Gulf of St. Lawrence and whose shoreline, a semicircle of about 100 miles radius, extends from Cape North to Cape Gaspe. The water which covers this plain is nowhere very deep, rarely exceeding 50 fathoms, and having an average depth of 30 or 40 fathoms. The major features of the plain are clearly of subaërial origin. Broad valleys which increase in depth from 30 to 90 fathoms cross the plain at its northwest and northeast corners, one draining Chaleur bay and the other passing close along the northwest coast of Cape Breton island to Cabot strait (See map).

Like Prince Edward Island, the Magdalens seem to be summits of upland districts which in Tertiary time overlooked the

broad river-worn lowland, but which were subsequently separated from the mainland by widespread coastal subsidence, probably early in the Pleistocene. Since the submergence of the lowland, the islands in their exposed position have suffered on all sides

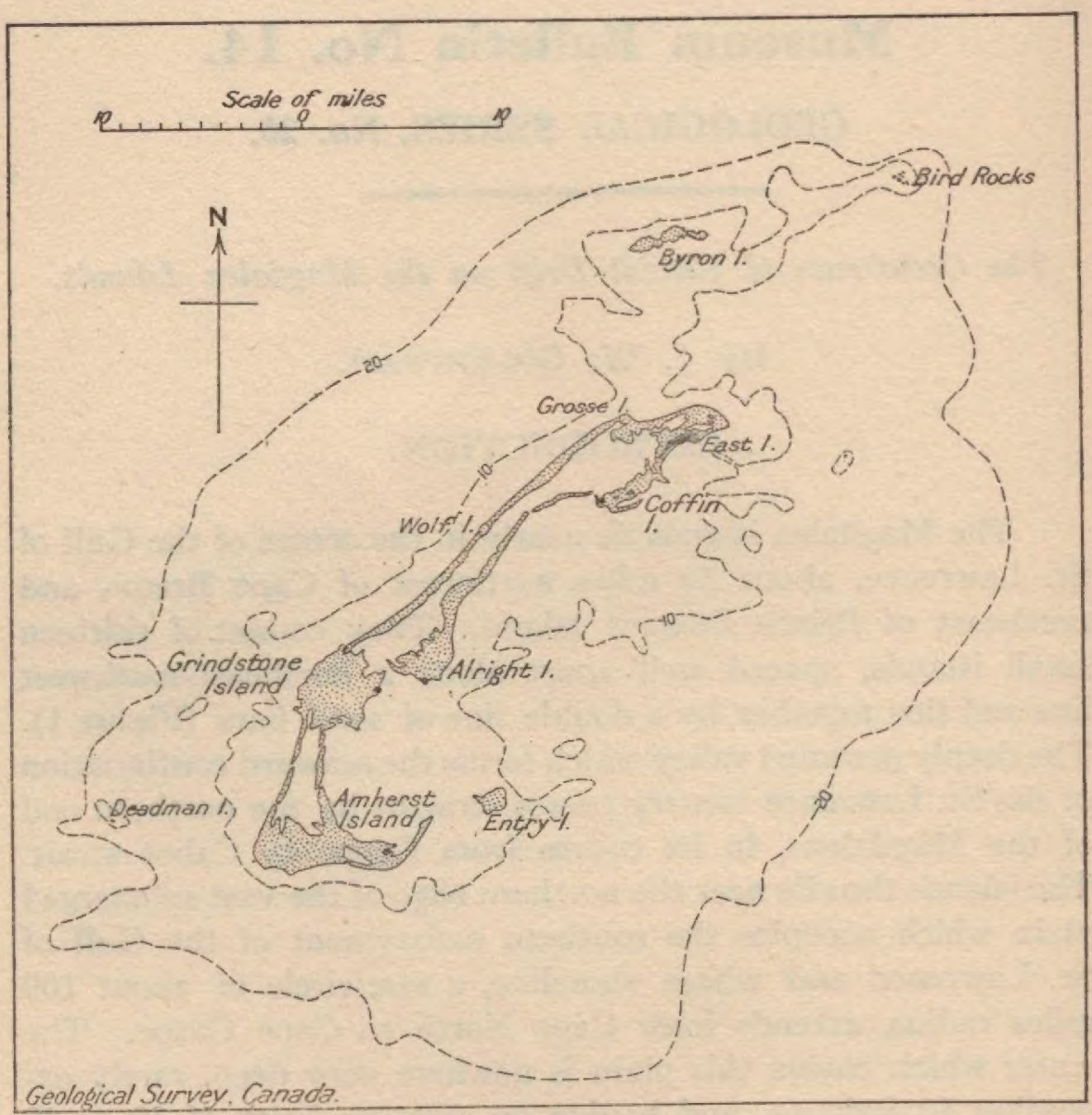

Figure 1. The Magdalen islands.

from the attack of the sea. In the cliffs which encircle them, one can see almost continuous sections of red and grey Carboniferous sandstones and black volcanic rock, contrasting in an attractive way with the smooth green slopes of pasture and forest which rise inland to curious dome-shaped summits. These round hills or "demoiselles" as they are called complete a landscape which

is most unusual, suggesting the volcanic islands of the Straits of Java rather than an outlying scrap of Canada.

PREVIOUS WORK.

The surface geology of the islands has been studied only incidentally. It is generally believed that they are non-glaciated. James Richardson in his report of 1881[1] says: "The relations of superficial deposits are rather obscure. Nowhere could deposits of clay or gravel be distinguished such as are usually attributed to the drift period. The surface is everywhere covered with a mantle of soil of similar quality throughout, lying on the upturned edges of the older rocks. . . . No rocks were observed to protrude through the soil, which everywhere extends from the lowest to the highest levels.[2]

"On account of the generally soft and friable nature of the rocks no glacial grooves or scratches are to be seen; whether, therefore, any such ever existed is uncertain."[3] Boulders from foreign sources are said to be scarce and the nature of their transportation hither is regarded as uncertain. None at all were found on Amherst island. Rounded blocks and boulders from 2 or 3 pounds weight to 40 pounds, and in rare instances to over a ton were found on the beach at Grindstone island and Wolfe island; and in the latter case they appeared to have come from a deposit at the top of a sandstone cliff. Most of them were of white quartz rock, but some were a chloritic and micaceous schist, said to resemble Laurentian rocks.[4]

While not committing himself definitely, therefore, to an opinion, Richardson emphasized the lack of any clear evidence that the Magdalens had been glaciated, and the probability that their soils were essentially residual in origin.

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[1] James Richardson. Report of a geological exploration of the Magdalen islands, 1880-1881. Geol. Surv., Canada, Report of Progress, 1879-80, Part G, pp. 11, 1881.

[2] Op. cit., pp. 8-10.

[3] Op. cit. p. 9.

[4] Op. cit. p. 9.

Dr. Robert Chalmers, who visited the Magdalens about 1890, in search primarily of evidence touching the glacial history of the islands, was more positive in his statements. "The Magdalen islands," he says,[1] "were discovered to be unglaciated"; and further, "no evidences of Pleistocene ice action or of the occurrence of boulder clay were observed; on the contrary, the rock surfaces are everywhere masked with a covering of their own debris."[2] After describing the complex structural relation of the intrusive diabases and the sandstones, Chalmers says: "Upon the surface of the whole lie thick beds of rotted rock in situ without any boulder clay or glaciated material. On the northeast sides of Amherst and Grindstone islands a few pebbles and boulders were observed which may be foreign to them, but even these were not glaciated. The residuary materials were modified on the surface below the 110 to 115-foot contour lines by the action of the sea during submergence, while above that level no trace of marine or glacial action could be observed. Indeed, the whole examination of the surface of the four largest islands, Amherst, Entry, Grindstone, and Alright failed to show any evidence of glaciation whatever. Rotted rock alone, with stratified marine beds up to the highest marks of the Pleistocene submergence, are everywhere the prevailing superficial deposits; above the shoreline referred to some stratified lenticular sheets, due to atmospheric action, occupy the surface and overlie the residuary material; but the pebbles and debris are mostly angular and unworn." Continuing, he says: "It is possible, however, that more detailed investigation might result in showing evidences of at least the impingement of floating ice against the slopes or coast borders of these islands."[3] Again, he reports: "A few small crystalline boulders were observed on the northwest sides of Amherst and Grindstone islands; but whether transported or derived from the central crystalline hills of each could not be determined in the limited time at my disposal. It is not improb-

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[1] Robert Chalmers. Report on the surface geology of eastern New Brunswick, northwestern Nova Scotia, and a portion of Prince Edward Island. Geol. Surv. of Canada, Annual Report, Vol. VII, 1895, Part M, p. 94.

[2] Op. cit. p. 108.

[3] Op. cit., p. 49.

able that they were borne hither by floating ice when these islands stood at a lower level, though none were found in the sand beach of the recent period. As stated already, no boulder clay was found on the four largest islands of the group, viz., Amherst, Grindstone, Entry and Alright."[1]

Chalmers thus corroborated what Richardson had said concerning the uniform covering of residual deposits, the lack of boulder clay, and the doubtful significance of the foreign stones, adding only the conception of a Pleistocene submergence of about 100 feet, with floating ice as the possible agency which had brought the crystalline boulders.

Dr. John M. Clarke in his "Observations on the Magdalen Islands"[2] says: "The soil of the islands is essentially residual. The islands have never been subjected to glacial action. One finds on the sand spits and on the lower rock platforms especially of the northern islands plenty of ice-borne boulders, for the most part dropped where they lie, and now glazed by the blown sand, but there has been no disturbance of the soil by ice erosion. Hence the softer red rocks, which are largely feldspathic, have undergone deep decomposition in place, and, under the vegetable mould at the top, the soil extends downward often for 5 or 6 feet, carrying all the structure of the stratification and passing by evidences of less and less decay into the disintegrating layers of the sandstone and thence into the solid rock."[3]

Regarding foreign boulders and pebbles such as Richardson and Chalmers described, Dr. Clarke says: "These boulders are ice borne, dropped where they lie by icebergs and floe ice of no recent date. It is very noticeable that these ice-carried blocks are much more abundant in the northern islands, Coffin and Grosse isle, and that here nearly every example, whether on or in the soil, is a dreikanter, while on the southern islands such blocks are seldom angled by this etching. This fact is naturally explained by the much more exposed situation of the northern islands."[4] Sand-blasted crystalline boulders are said to occur

[1] Op. cit., p. 55.

[2] New York State Museum Bulletin No. 149, Seventh Report of the Director, 1910, 53 pp.

[3] Op. cit., pp. 18-19.

[4] Op. cit., p. 21.

also in large numbers in deeply decayed and bleached sandstones at Grosse Isle head, indicating the eolian character of that rock formation. On Grindstone island an irregular gravelly layer of "small angular diabase pebbles" accompanied by larger boulders is said to occur similarly in decayed sandstone.

Summing up the reports of these three observers, we learn that: (a) a sheet of rotten sandstone of strictly residual origin and quite undisturbed by glacial action covers much of the surface of the Magdalens; (b) in places this deposit contains boulders and pebbles of quartzite and chlorite schist, whose surfaces seem in no case to be ice worn but are frequently sand blasted; (c) no glaciated surfaces have been found on the islands and no boulder clay is known to occur there; (d) such crystalline boulders as are known to exist at certain places on the beaches may have been transported hither by pack ice either in modern times or during the period when the upper sandstone accumulated, being subsequently released from it by weathering; and (e) there are somewhat questionable evidences of marine submergence to about 100 feet.

NEW OBSERVATIONS.

Early in September, 1913, the writer paid the Magdalens a brief visit in order to see if possible whether evidences of glaciation there were indeed absent; for the season's field work in Nova Scotia and Cape Breton had pointed rather to the probability that these more northerly islands also had been reached by the continental ice sheet. In order to ensure getting results within the limits of time that remained, the plan was hit upon of leaving the mail boat, "*Lady Sybil*" at the first promising spot where a landing was made, and remaining there for field work until the return of the boat several hours later. Thus it was hoped definite knowledge might be obtained on at least one of the islands. It happened, however, that at Amherst, where the first stop was made for 20 minutes, a deposit of boulder clay was found within 3 minutes' walk of the pier, and glaciated stones were collected from it; so that it seemed advisable instead of remaining there to go ahead with the boat, and by similar half-

hour visits to locate if possible like evidences of glaciation on the other islands touched by the "*Lady Sybil.*" While the results obtained at the other points visited were less convincing than those at Amherst, they lend strength to the opinion that glacial drift occurs on all the islands.

AMHERST ISLAND.

At "Fishtown point," where the pier extends out into Amherst harbour, a cross section of the cliffs shows deeply decayed, buff-weathering sandstone overlain by an unstratified sheet of red sand and a thin coating of wind-blown sand. The red deposit contains pebbles of brownish black diabase, the common intrusive rock of the Magdalens, and more rarely of quartz. The origin of it is somewhat obscure at first glance.

A few hundred yards away, however, behind the fish houses a cliff which faces over the "basin" exhibits a section of a much thicker deposit of red sand which here has the characteristics of glacial till. The deposit is about 15 feet thick, and rests on the buff-weathering grey sandstone already mentioned. In the red matrix is an abundance of pebbles which average from 2 to 5 inches in diameter but include a few boulders of much larger size. Approximately 80 to 85 per cent of the stones are of local derivation—that is, not from the underlying sandstone, but from the diabase hills of the islands; the other 15 or 20 per cent include grey and white quartzite, vein quartz, feldspar porphyry, and coarse biotite granite. Many of these stones are round; but in general there is as large a proportion of angular and subangular stones as is usual in glacial till. Several of the diabase pebbles collected during a ten minute search show distinct striæ on their broader faces, with a pronounced tendency to parallelism with the long axis of the pebble. In the opinion of the writer these are ice worn (Plate I). Except at the top, where 3 or 4 feet of eolian sand covers this red boulder clay, there is no indication of bedding in the deposit. The stones stand in all sorts of positions, and in thorough disorder. The sandstone beneath, where exposed, seems to be too deeply decayed to furnish glacial striæ. A few of the pebbles at the base of the

eolian sand show the glazing and facetting peculiar to wind scour. The largest boulder noticed was a granite boulder 3 by 2 by 2 feet, at the foot of the bluff, on the shore of the basin.

Granting that this is an ice-borne deposit, unlike any that has been reported hitherto from the Magdalens, the question, of course, arises: is it the deposit of a continental glacier or of sea-ice during a period of submergence? The absence of stratification and the rather considerable thickness of the deposit would seem to indicate that it is true ground moraine. Although the foreign stones might have been brought either by an ice sheet or by drifting sea ice, the well worn shapes and the striated surfaces of the stones of the local diabase are less easily explained as the product of sea-ice than as the product of a slowly advancing ice sheet, particularly because of the strong longitudinal tendency of the striæ already mentioned. Local pebbles encased in shore ice or icebergs would as likely acquire scratches in directions oblique and transverse to their long axes as parallel to them; in short, the scratches would run without system in all directions. For these reasons, and because of evidence of the glaciation of nearby coasts, to be mentioned more particularly later, the writer holds the view that the deposit at Amherst is glacial till.

Looking towards the village of Amherst from the pier, one sees in the cliffs near Demoiselle hill a red mantle of sand or boulder clay unconformably overlying the buff-weathering sandstone and the black diabase. Although time did not permit close inspection of this place, it seems likely that the red boulder clay at Fishtown extends across the island to Demoiselle hill.

GRINDSTONE ISLAND.

At Cape aux Meules, where the boat touches Grindstone island, the evidence of glaciation is indeed obscure. The high hill of grey sandstone which overlooks the pier is covered with a sheet of residual soil 3 feet thick, answering the descriptions of Richardson and his successors in the field. Not a single foreign pebble was found in this mantle—only the discoidal fragments of decayed sandstone. Along the cliffed shore about a quarter of a mile north of the pier, however, one finds the

decayed sandstone overlain by rather well stratified gravel, in which the stones are mainly of the common diabase which outcrops not far away. Just beyond here is an unstratified or obscurely stratified deposit of hard red clay containing angular stones of the volcanic rock. A few of these seem to be "soled" and dimly striated. The glacial origin of the deposit, however, is by no means as clear as that at Amherst. Considered alone the evidence at Grindstone island would be of little value.

ALRIGHT ISLAND.

At Point Bosse a high dome-shaped hill like the one at Cape aux Meules exhibits the same structure of hard buff-weathering sandstone. Near the base of the hill beside the village road is a section exposing a mantle of 2 or 3 feet of unstratified reddish sand containing stones, followed, below, by 3 feet of red gravel, which in turn covers the deeply decayed red and grey sandstone. The gravel consists mainly of subangular and discoidal pebbles of diabase, but includes also vein quartz, grey and white quartzite, feldspar porphyry, syenite, diorite, coarse granite, and labradorite. Although nearly all of the stones here have rounded surfaces, two or three were found which have typical subangular form, and one of these is delicately but clearly marked with fine striæ which run lengthwise on the stone, appearing on the treads of three step-like projections but failing in the re-entrant angles between the steps. Here, on Alright island, as at Cape aux Meules, the evidence is not convincing, since the material might be sufficiently accounted for by sea-ice drifting against or across the surface of the island during a period of greater submergence. The heterogeneity of the deposit, however, requires at least a distant source for it.

COFFIN ISLAND.

The landing for the boat at Grand Entry is at the extreme southwest corner of Coffin island on a low sand spit. About half a mile from the pier along the cart road the low sea cliff exposes a section of cross-bedded red sandstones covered by a

few feet of stratified white sand. In the sand are pebbles and subangular stones of diabase and foreign types. At one spot also a patch of hard red till (?) was seen at the base of the sands. The stones include quartzite, coarse syenite, syenite porphyry, and augen gneiss. None of them display striæ, although their shapes are in a number of cases suggestive of glacier wear. The upper sides of those stones which were embedded in the stratified sand were in most places glazed and pitted by the sand blast.

SUMMARY.

On the accompanying map is shown the direction of glacial striæ in neighbouring parts of the Maritime Provinces. The observations in Nova Scotia and Cape Breton are new; those elsewhere are compiled from the most reliable sources available. A glance at this map will indicate the probability that the Magdalen islands were glaciated by ice from the north. Although a great eastward movement from a centre in New Brunswick is recorded by striæ in that province and Prince Edward Island, the dominant movement in the region southeast and south of the Magdalens, namely, Cape Breton and northern Nova Scotia, was southward, with a divergence towards the semi-circular border of the shallow basin in which, as already noted, the Magdalen islands occupy a nearly central position. It is difficult to see how the ice sheet could have advanced southeastward over the high tableland of northern Cape Breton and southward across the mountainous isthmus of northern Nova Scotia without covering the Magdalens. Indeed, considering the fact that the water around these islands is only 30 to 40 fathoms in depth, it seems likely that the ice also crossed the Magdalens during the epoch of eastward movement from the New Brunswick centre.

While final judgment may properly await more thorough field study, enough has been collected in this hurried reconnaissance to make it seem probable, at least, that the islands were covered by ice during one or more of the epochs of the glacial period. To be sure, a blanket of decayed sandstone covers much of the surface. The condition in this respect, however, is not

altogether unlike that on Prince Edward Island, where, as others have reported, the ground moraine is composed almost exclusively of weathered material from the underlying red sandstone, and striated ledges are very difficult to find. The stony sands which cover the decayed rock in several of the localities on the Magdalens and which contain not only the diabase from adjacent hills but also stones of several types foreign to the islands, require a transporting agency which must be either floating sea ice, as Dr. Chalmers and Dr. Clark have supposed, or glacial ice. The presence of soled and striated pebbles on Amherst and Alright islands would not seem to fully settle the question of the nature of this ice, although for the production of longitudinal striæ on pebbles it is thought that an ice sheet furnishes the better opportunity. The thickness of the mantle of boulder clay on Amherst island, together with its physical and lithological heterogeneity, furnish the main ground for the belief that continental ice has covered the Magdalens.

Diagram showing **St. Lawrence submerged coastal plain**

To accompany Bulletin by J. W. Goldthwait.